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12/3,K/5 (Item 5 from file: 348)

DIALOG(R)File 348:EUROPEAN PATENTS

00450623

VARIABLE SKEW FAN.

GEBLASE MIT ANDERLICHEM SCHIEFSTAND.

SOUFFLANTE A OBLIQUITE VARIABLE.

PATENT ASSIGNEE:
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FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS B	(English)	EPAB95	186
CLAIMS B	(German)	EPAB95	188
CLAIMS B	(French)	EPAB95	216
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Total word count - document A			0
Total word count - document B			1958
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...SPECIFICATION hub 12 to their respective tips, where they are joined to band 11.

The fan **blades** have **different** shapes, with each of the **blades** having a **different** " **blade skew** ." The **blade skew** is defined as the angle A(sub(b)) between the midpoint (M(sub(r))) of...

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(54) **VARIABLE SKEW FAN.**

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DE-C- 3 801 353
US-A- 1 868 008
US-A- 4 253 800
US-A- 4 569 631
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US-A- 4 684 324
US-A- 4 685 513
US-A- 4 729 714

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Description

Background of the Invention

This invention relates generally to fans having several blades used to move a fluid such as air. In particular, the invention features a fan having blades with variable skew. (I.e., the blade skew varies between at least two of the fan blades.)

Fans are typically constructed with identical blades that are attached at a common hub, the hub being rotated by, e.g., an electric motor through a shaft attached to the hub, see for example document US-A-4 569 632. The blades are usually evenly spaced around the periphery of the hub. When the inflow velocity of air entering a fan varies (especially circumferential variations), the fan will often generate audible tones at frequencies corresponding to the blade passing frequency (i.e., the frequency at which the blades pass a fixed point) and multiples of the blade passing frequency.

In order to reduce the magnitude of these tones, fans have been constructed with blades located at uneven intervals around the periphery of the hub. (See, e.g., U.S. Patent No. 3,315,749 to K. W. Parsons et al.) When the blades are unevenly spaced, tones are generated at the same frequency as the frequency at which the shaft rotates, and at multiples of that frequency. Since the shaft rotation frequency is much less than the blade passing frequency, the total number of tones generated within any frequency band is much greater than in the case of evenly spaced blades, and the strength of each tone is correspondingly reduced. If reduced sufficiently, these tones can become inaudible due to the masking effect of various broadband noise sources, including the fan itself. A further advantage of having blades that are unevenly spaced is that the frequency of the lowest frequency tones produced is in a frequency range where the human ear is relatively insensitive. In this way fan noise can be made less objectionable.

DE-C-3 801 353 discloses a fan for use as propellers or jacketed air screws where it is desirable to be able to vary blade pitch mechanically. The blades have varying sweep angles and are equally spaced at the hub to facilitate adjustment of blade pitch.

The invention generally features an axial flow fan that achieves the advantages of having the blades unevenly spaced without sacrificing performance as do previous fans that employ uneven blade spacing. The fan of the invention, unlike previous fans, uses blades that are essentially evenly spaced near the hub, but have variable spacing near the tip sections of the blades, to reduce audible tones. Since the noise produced by the sections of the fan blades near the hub is negligible compared to the noise produced by the tip sections of the blades, the advantages of uneven blade spacing are realized by having only the tip sections of the blades unevenly spaced. This is achieved by varying the "skew" of at least two of the blades. Skew is defined as the angle between the midpoint of the blade root and the midpoint of the blade tip, and is explained in greater detail below.

The fan of the invention generally comprises: a central hub rotatable on an axis; and a plurality of blades extending from the hub, each of the blades comprising a root portion adjacent to the hub, and terminating in a tip portion, wherein said fan is a single piece, injection molded, said blades being integrally moulded with said hub, the root portions of the blades being approximately evenly spaced around the hub; wherein each of the blades exhibits a curvature from the root portion of the blade to the blade's tip portion, the curvature being in a plane that is perpendicular to the axis on which the fan rotates; and wherein the curvature differs between at least two of the blades, such that the distance between the tip portions of at least two sets of adjacent blades is unequal.

In one preferred embodiment, the blades are "backskewed" (i.e., skewed in a direction opposite to the direction of rotation of the fan), and each of the blades is skewed by a different amount. In another preferred embodiment, the fan includes at least two identical groups of blades. The distance between the blade tips of at least two sets of adjacent blades varies by at least a factor of 1.5. The blade tips are connected by a band.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Drawings

Fig. 1 is a plan view of a fan according to the invention.

Fig. 2 is a plan view of a second embodiment of the invention.

Structure and Operation

Referring to Fig. 1, a fan 10 has a cylindrical hub section 12 for housing a motor (not shown). The motor shaft is attached to the hub at aperture 14 and thus rotates the fan. A plurality of blades, blades 16-19 being shown as illustrative, extend radially outward from hub 12 to their respective tips, where they are joined to band 11.

The fan blades have different shapes, with each of the blades having a different "blade skew." The blade skew is defined as the angle A_b between the midpoint (M_r) of the blade root and the mid-

point (M_t) of the blade tip. As can be seen in Fig. 1, the skew angle A_b is substantially greater for blade 17 than for blade 18. However, all blades are approximately evenly spaced at the hub so that the distance between the midpoints M_r ofeach blade root in fan 10 is approximately equal. Since the blades have a variable skew as described above, the distance between the tips of the blades will vary. I.e., the distance between the midpoints M_t will vary, achieving the advantages of reduced noise described above. Since the blades are evenly spaced at the hub, however, the hub will have a high solidity resulting in superior aerodynamic performance, as explained in detail below.

A disadvantage of having uneven blade spacing is that the aerodynamic performance can be degraded, particularly for the sections of the blades near the hub, which work at a higher "non-dimensional loading" than the sections of the blades near the tips of the blades. Non-dimensional loading is the ratio of the change of pressure across the fan to the product of the density of the fluid moved by the fan and the square of the speed of the fan blades. Since non-dimensional loading is inversely proportional to the square of the blade speed, and because the speed of the tips of the blades is greater than the speed of the sections of the blades near the hub, fans are more heavily loaded near the hub, and therefore require a higher solidity near the hub than near the tip sections. This solidity is often limited by the requirement that the fan be injection moldable (i.e., the blades cannot overlap). If the root sections of the blades are unevenly spaced, the requirement that the blades not overlap will further limit blade design in the areas where the blades are close together. In those areas where the blades are spread further apart, high solidity will be achievable only by increasing blade chords, which in turn will increase the projected width of the fan. In applications such as automotive cooling systems, where the fan must be compact, this increase in fan width is often not acceptable, so the solidity at the blade root will be made smaller than aerodynamic considerations deem desirable. As explained above, however, the present invention uses blades with varied skew to achieve the advantage of varied spacing at the tips of the blades, while maintaining even spacing near the hub, resulting in high solidity near the hub.

As described above, the preferred embodiment is a fan with blades whose skew distribution varies from blade to blade. However, two or more identical groups of blades may be used, each of which would contain at least two blades. Referring to Fig. 2, a fan 20 is shown that comprises two identical blades 22 and two identical blades 24, forming at least two identical groups of blades (i.e., each group includes one blade 22 and one blade 24). The use of identical groups makes it easier to design a fan that is both dynamically and statically balanced. Using identical groups of blades also reduces the number of different blade designs.

The preferred embodiments are merely illustrative and other embodiments are within the scope of the appended claims.

Claims

1. An axial flow fan comprising:
   a central hub rotatable on an axis; and
   a plurality of blades extending from said hub, each of said blades comprising a root portion adjacent said hub and terminating in a tip portion;
   wherein said fan is a single piece, injection molded, said blades being integrally molded with said hub; said root portions being approximately evenly spaced around said hub;
   wherein each of said blades exhibits a curvature from said root portion to said tip portion, said curvature being in a plane that is perpendicular to said axis;
   said fan being characterised in that
   said curvature differs between at least two of said blades, such that the distance between the midpoint of said tip portions of at least two sets of adjacent blades is unequal.

2. The fan of claim 1 wherein said blades are backskewed.

3. The fan of claim 1 comprising at least two identical groups of blades.

4. The fan of claim 1 wherein the distance between said blade tips of said at least two sets of adjacent blades varies by at least a factor of 1.5.

5. The fan of claim 1 where said blade tips are connected by a band.

Patentansprüche

1. Axialstromventilator, bestehend aus:
   einer zentralen, auf einer Achse rotierend gelagerten Ventilatornabe; und einer Vielzahl von der Ventilatornabe ausgehenden Ventilatorblättern, dabei besteht jedes der Ventilatorblätter aus einem Fußabschnitt in der Nähe der Ventilatornabe und endet in einem Spitzenabschnitt, wobei der Ventilator aus einem einzigen Stück besteht, im Spritzgußverfahren hergestellt wird, die Ventilatorblätter integral mit der Ventilatornabe vergossen sind, und die Fußabschnitte der Ventilatorblätter ungefähr gleichmäßig rund

um die Ventilatornabe verteilt sind;
wobei jedes der Ventilatorblätter einen Kurvenverlauf vom Fußabschnitt bis zum Spitzenabschnitt aufweist, wobei der Kurvenverlauf in einer Ebene liegt, die senkrecht zur Achse verläuft,
wobei der Ventilator dadurch gekennzeichnet ist, daß der Kurvenverlauf bei mindestens zwei der Ventilatorblätter abweichend ist, so daß der Abstand zwischen den Mittelpunkten der Spitzenabschnitte von mindestens zwei Sätzen benachbarter Ventilatorblätter ungleich ist.

2. Ventilator entsprechend Anspruch 1, wobei die Ventilatorblätter eine Rückwärtsschrägung aufweisen.

3. Ventilator entsprechend Anspruch 1, der mindestens zwei identische Gruppen von Ventilatorblättern aufweist.

4. Ventilator entsprechend Anspruch 1, wobei der Abstand zwischen den Blattspitzen von mindestens zwei Sätzen benachbarter Ventilatorblätter um einen Faktor von mindestens 1,5 abweicht.

5. Ventilator entsprechend Anspruch 1, wobei die Spitzen der Ventilatorblätter durch ein Band miteinander verbunden sind.

Revendications

1. Ventilateur à écoulement axial, comprenant :
   - un moyeu central capable de tourner sur un axe ; et
   - une pluralité de pales qui s'étendent depuis ledit moyeu, chacune desdites pales comprenant une partie de racine adjacente du moyeu et se terminant dans une partie d'extrémité ;
   dans lequel ledit ventilateur est d'une seule pièce moulée par injection, lesdites pales étant moulée de façon intégrée avec ledit moyeu ; lesdites parties de racine étant espacées de façon approximativement égale autour dudit moyeu ;
   dans lequel chacune desdites pales présente une courbure depuis ladite partie de racine jusqu'à ladite partie d'extrémité, ladite courbure étant dans un plan qui est perpendiculaire audit axe ;
   ledit ventilateur étant caractérisé en ce que ladite courbure diffère entre au moins deux desdites pales, de telle sorte que la distance entre le point médian desdites parties d'extrémité d'au moins deux groupes de pales adjacentes est inégale.

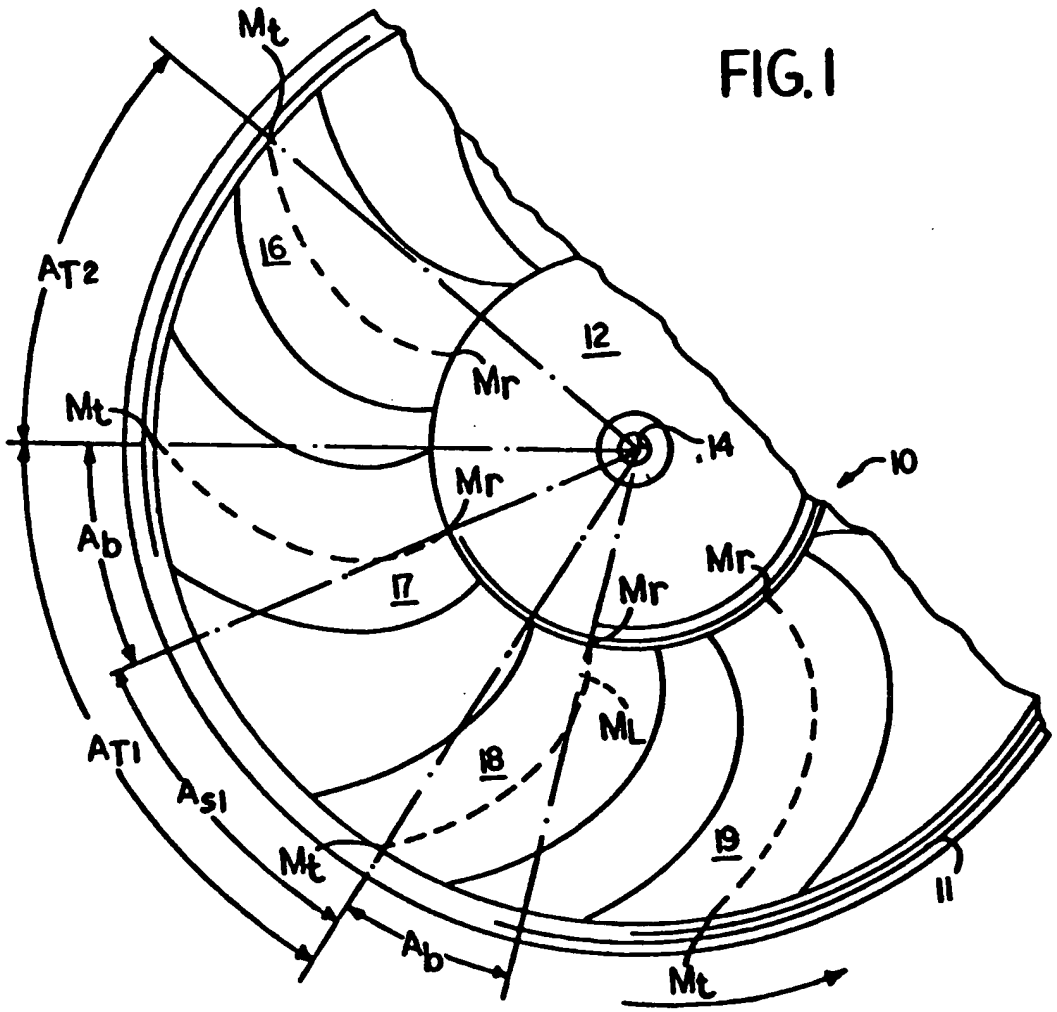
2. Ventilateur selon la revendication 1, dans lequel lesdites pales ont une inclinaison rétrograde.

3. Ventilateur selon la revendication 1, comprenant au moins deux groupes identiques de pales.

4. Ventilateur selon la revendication 1, dans lequel la distance entre lesdites extrémités des pales desdits au moins deux groupes de pales adjacentes varie d'un facteur au moins égal à 1,5.

5. Ventilateur selon la revendication 1, dans lequel lesdites extrémités des pales sont reliées par une bande.

FIG. 1



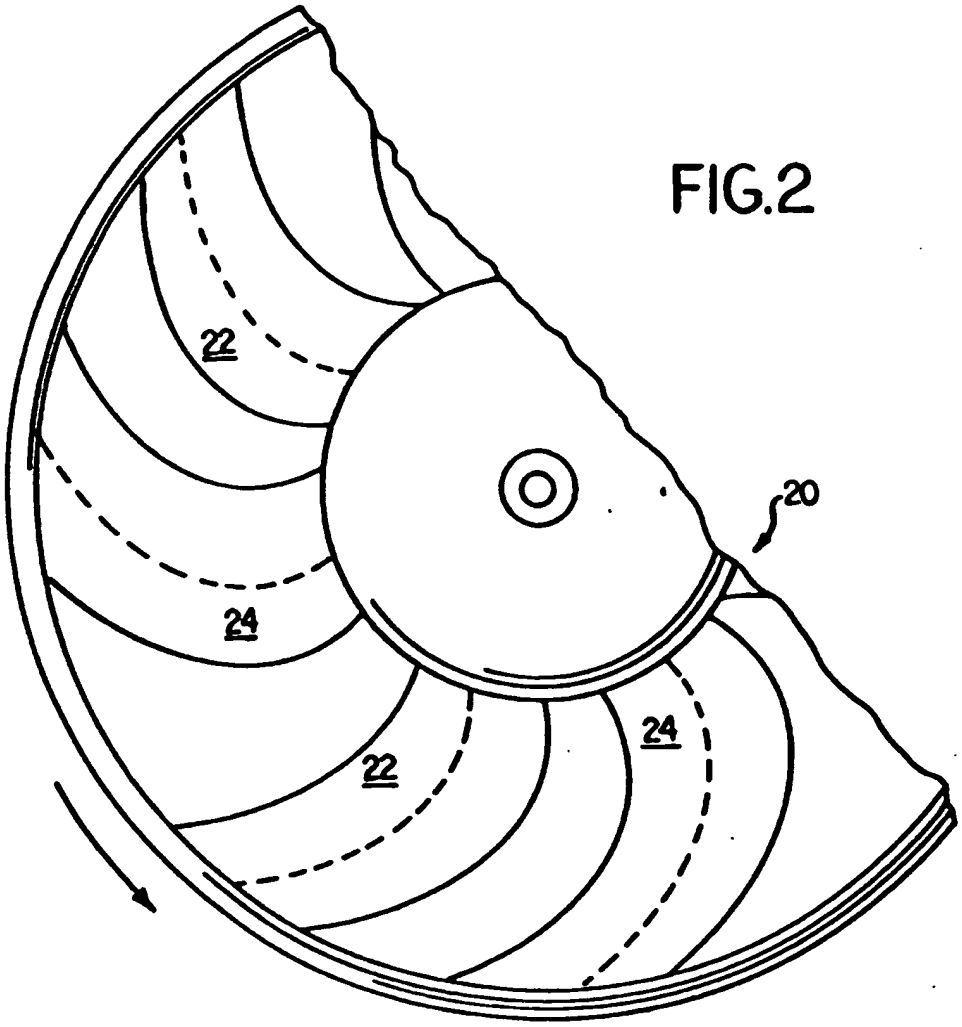


FIG.2

European Patent Office

SUPPLEMENTARY EUROPEAN SEARCH REPORT

Application Number

EP 90 91 1885

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-C-3 801 353 (RHEIN-FLUGZEUGBAU) * the whole document *	1,3,5	F04D29/38 F04D29/32
Y		2,4	
Y	US-A-4 569 632 (GRAY) * claim 1; figures 1,2 *	2	
A		5	
Y	US-A-4 253 800 (SEGAWA) * column 4, line 23 - line 36; figure 5 *	4	
A	US-A-1 868 008 (GARDNER) * the whole document *	4	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F04D
B64C

The supplementary search report has been drawn up for the claims attached hereto.

Place of search	Date of completion of the search	Examiner
THE HAGUE	04 MARCH 1992	TEERLINGS J.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)

CLAIMS

1. An axial flow fan comprising:

a central hub rotatable on an axis; and

a plurality of blades extending from said hub, each of said blades comprising a root portion adjacent said hub, and terminating in a tip portion, said root portions being approximately evenly spaced around said hub;

wherein each of said blades exhibits a curvature from said root portion to said tip portion, said curvature being in a plane that is perpendicular to said axis; and

wherein said curvature differs between at least two of said blades, such that the distance between the midpoint of said tip portions of at least two sets of adjacent blades is unequal.

2. The fan of claim 1 wherein said blades are backskewed.

3. The fan of claim 1 comprising at least two identical groups of blades.

4. The fan of claim 1 wherein the distance between said blade tips of said at least two sets of adjacent blades varies by at least a factor of 1.5.

5. The fan of claim 1 where said blade tips are connected by a band.